

REMARKS

The Applicant thanks the Examiner for comments in the office action mailed September 9, 2004, and for indicating the allowability of claim 17 if rewritten in independent form. An amendment to the specification is hereby entered to update paragraph [0001].

The Applicant respectfully traverses the Examiner's rejection for double patenting, 35 U.S.C. 102, and 103. A declaration of the inventor, who is an expert in his field, is attached that explains why the claimed invention is neither anticipated by nor obvious over the subject matter disclosed in the references cited by the Examiner.

Double Patenting

With respect to claims 15-16 and 18, the claims are patentably distinct from claims 9-10 of U.S. Pat. No. 6,689,486 (the "Parent Application"). A three-dimensional thin film is not shown in Fig. 33 nor disclosed in paragraph [0080]. Claims 9 and 10 do not claim a three-dimensional thin film. Claims 9 and 10 read, as follows:

9. A microscale actuator for active flow control, comprising: a SME thin film comprised of nickel and titanium, wherein the thin film is sputter-deposited, and the thin film comprises a bubble membrane, and the thin film has a compositional gradation through at least a portion of the thickness of the thin film, and the compositional gradation is selected such that a phase change occurs above room temperature, wherein the phase change is capable of activating a two-way shape memory effect in the bubble membrane.

10. A micro scale actuator of claim 9, wherein the bubble membrane extends when heated and flattens when cooled.

A bubble membrane is not produced by use of a three-dimensional thin film. Instead, the bubble membrane is created from a planar sheet of thin film produced by the process disclosed in the Parent Application, as shown in col. 11, ll. 21-27, which describes the bubble membrane as flattening out. Instead of a three-dimensional thin film, the thin film, itself, is merely a planar

thin film, formed by standard lithographic techniques, that is distorted out-of-plane to form a bubble membrane actuator by a conventional deformation process that is well known in the field of shape memory effect devices. In contrast, the three-dimensional thin films of the present invention are, themselves, three-dimensional, having been formed on a three-dimensional substrate scaffold, as described in paragraph [0017] and shown in Figs. 13-15, for example. The thin film of these examples is formed around a removable or sacrificial substrate scaffold. Thus, the thin film, itself, has a three-dimensional shape, as deposited on the substrate scaffold. Again, this is contrasted to the device described in paragraph [0078] of the present application that is formed from a planar thin film and subsequently curls out-of-plane to form a cage. The thin film, itself, is not a three-dimensional structure. This is a patentably distinct difference between the Parent Application and the present invention.

Rejection Under 35 U.S.C. 102

Claims 12-15 and 19 are not anticipated by Hill (U.S. Pat. No. 6,775,046) under 35 U.S.C. 102(e), because Hill fails to disclose each and every limitation of the claimed invention in such detail that a person of ordinary skill in the art, at the time the application was filed, would have had a reasonable expectation of success without undue experimentation. Specifically, the declaration of the inventor, which is attached hereto, shows that the only non-titanium example that Hill suggests as a candidate shape memory alloy is gold copper, AuCu, (col. 2, ll. 45-49), which does not exhibit a two-way shape memory effect by any known processing conditions. Indeed, Col. 4, ll. 13-23 of Hill teaches that one aspect of the invention is to have a shape memory material of a two-way type and for "that two-way type ... the layer of shape memory material comprises a compositionally graded layer of shape metal alloy, which in the preferred embodiment ranges in grade from 49% nickel and 51% titanium to 51% nickel and 49% titanium and, in thickness, in the range of five and twenty microns." Thus, the disclosure of Hill teaches away from non-titanium shape memory materials for realizing shape change materials of the two-way type.

Furthermore, there is no specific target chemistry, target temperatures, vacuum pressures or other processing conditions for achieving a two-way shape memory material. Thus, achieving a two-way, non-titanium shape change material would require undue experimentation for a person of ordinary skill familiar with the art of ordinary shape change materials. To determine the correct proportions of a non-titanium shape change alloy and the correct range of processing conditions, as presented in the declaration of the inventor, the multitude of possible shape memory alloys would require selection, experimentation and characterization of alloys and processing conditions. Such work requires expensive equipment, special customization of the equipment, preparation of custom targets, growth of thin films under various processing conditions and characterization of the materials prepared. Reduction to practice for a single alloy system can take years of computations, trial-and-error experiments and characterization. Thus, a routiner in the art would not have a reasonable expectation of success in developing a non-titanium, two-way shape memory thin film based merely on the general disclosure presented in the Hill reference.

The disclosure of Hill does not disclose "...a film comprising a shape memory alloy having substantially no titanium ... wherein the phase change activates a two-way shape memory effect," as recited in claim 12. In order to anticipate a claim, a reference must disclose each and every limitation of a claim exactly and in sufficient detail that a person of ordinary skill in the art would have a reasonable expectation of success without undue experimentation. Hill fails to disclose any alloy of two-way type, except for a Ni:Ti binary alloy having a narrow range of compositions including titanium. Thus, Hill fails to disclose each and every limitation of claim 12, and claim 12 is not anticipated by Hill.

Rejection Under 35 U.S.C. 103

Claims 1-16 and 18-20 are non-obvious over Ho (U.S. Publ. No. 2002/0043456) in view of Hill (U.S. Pat. No. 6,775,046) and further in view of Bement (U.S. Publ. No. 2002/0114108). The Applicant refers to the declaration by the inventor, which shows that developing new alloys and new processes for two-way shape memory effect thin films is a complex and time-consuming

process that requires extensive preparation, trial-and-error and computation to select the appropriate alloy systems, alloy compositions and processing conditions.

As presented earlier, the disclosure of Hill fails to teach or suggest the use of any non-titanium alloy for preparing a shape change material of two-way type.

The Parent Application, Ho, also fails to teach or suggest the use of any non-titanium alloy for preparing a shape change material of two-way type.

Bement also fails to teach or suggest the use of any non-titanium alloy for preparing a shape change material of two-way type.

In order to establish *prima facie* obviousness, a reference or combination of references must teach or suggest every limitation of a claimed invention. As none of the cited references teaches or suggests "introducing a source of a shape memory alloy other than a Ni:Ti-based alloy into the enclosure ... wherein the film is capable of exhibiting a two-way shape memory effect," as recited in claim 1; therefore, the cited references, either alone or in combination, fail to establish *prima facie* obviousness of claim 1.

Arguendo, even if *prima facie* obviousness were established by the combination of references, Bement and the declaration of the inventor show that the multitude of possible shape change alloys to choose from and the necessity to establish multiple processing conditions that are not known *a priori* requires undue experimentation for the development of new shape change materials. In addition the shape memory alloys and processes of the present invention have been developed to be much less sensitive to impurities, which allows lower vacuum pressures and greater relative distances between target and substrate, as described in the specification in paragraphs [0015], [0016], [0036] and [0079], for example. This led to a surprising and unexpected result, allowing two-way shape memory effect actuators to be fabricated having larger surface areas and thin films formed on three-dimensional substrate scaffolds. Therefore, claim 1 is non-obvious over the references cited.

Claims 2-11 depend from claim 1, incorporating all of the limitations of claim 1 and additional limitations; therefore, claims 2-11 are likewise non-obvious over the cited references.

Claim 12 recites "a film comprising a shape memory alloy having substantially no titanium...wherein the phase change activates a two-way shape memory effect." None of the cited references teach this limitation; therefore, *prima facie* obviousness is not established. Also, as for claim 1, secondary considerations, as shown in the declaration of the inventor and disclosed by Bement, show that claim 12 is non-obvious over the cited references.

Claims 13 and 14 depend from claim 12, incorporating all of the limitations of claim 12 and additional limitations; therefore, claims 13 and 14 are likewise non-obvious over the cited references.

Claim 15 recites "a film having a three-dimensional shape and comprised of a shape memory alloy, at least an operable portion of the film being capable of a two-way shape memory effect, the operable portion of the film having a uniform film thickness and a compositional gradient through at least a portion of the uniform film thickness...." None of the cited references, alone or in combination, teach or suggest a film, itself, having a three-dimensional shape and being capable of two-way shape memory effect, the operable portion of the film having a uniform film thickness. For example, Hill fails to teach or suggest how a three-dimensional shape capable of two-way shape memory effect having a uniform thickness would be produced in sufficient detail for a person of ordinary skill in the art to have a reasonable expectation of success. The declaration of the inventor shows the difficulty in achieving an invention of this kind, even for an expert in the field.

Claim 16 incorporates all of the limitations of claim 15 and an additional limitation to "wherein the three-dimensional shape of the film comprises a fenestrated tubular element." Fenestrated means having "window-like openings," according to The American Heritage® Dictionary of the English Language, Fourth Edition, Copyright © 2000 by Houghton Mifflin Company. None

of the cited references teaches or suggests fenestrated tubular elements having two-way shape memory effect; therefore, the cited references fail to establish prima facie obviousness.

Claim 18 incorporates all of the limitations of claim 15 and an additional limitation to "wherein the three-dimensional shape of the film comprises a dimpled spherical structure." None of the cited references teaches or suggests a dimpled spherical structure having two-way shape memory effect; therefore, the cited references fail to establish prima facie obviousness.

Claim 19 recites a "...shape memory alloy having substantially no titanium ... such that a phase change occurs above room temperature, wherein the phase change is capable of activating a two-way shape memory effect." None of the references, alone or in combination, teaches or suggests a shape memory alloy having substantially no titanium capable of activating a two-way shape memory effect. Furthermore, none of the references teaches or suggests such an alloy having a phase change occurring above room temperature. Therefore, the cited references fail to establish prima facie obviousness.

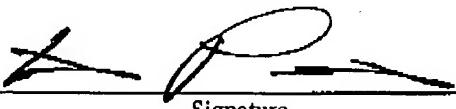
Claim 20 incorporates all of the limitations of claim 17, which the Examiner indicated would be allowable if rewritten in independent form; therefore, claim 20 is allowable if claim 17 is rewritten in independent form.

The Applicant respectfully requests that the amendment to the specification be entered. All of the claims are now in condition for allowance.

I hereby certify that this correspondence is being facsimile transmitted to the USPTO, Examiner John J. Zimmerman, Group Art Unit 1775, (703) 872-9306 on the date indicated below, including a declaration (affidavit) under Rule 1.131 and 1.132:

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Enclosure